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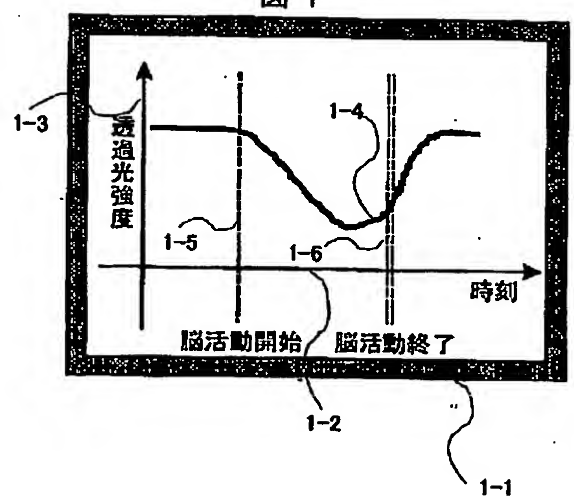
(54)【発明の名称】 光計測装置

(57)【要約】
【課題】脳活動の開始及び終了と、脳活動に伴う生体内代謝物質の濃度変化を被検査体が容易に把握することが可能な、意志誘導を行う光計測装置を提供する。
【解決手段】被検査体上に接触させた光照射器および光検出器を具備し、光を用いて被検査体の生体内代謝物質の濃度変化を計測する装置において、被検査体内部を伝搬した光の強度変化、或いはその強度変化から求めた生体内代謝物質の濃度もしくは濃度変化を実時間表示する装置と、被検査体が脳の活動の開始もしくは終了を認識せしめるために、被検査体の視覚もしくはを刺激する呈示装置を具備する。

図１



【特許請求の範囲】

【請求項１】光を用いて被検査体の生体内代謝物質の濃度もしくは濃度変化を計測する光計測装置において、被検査体上に接触させる光照射器および光検出器と、被検査体内部を伝搬した光の強度変化、或いは、その強度変化から求めた生体内代謝物質の濃度もしくは濃度変化を表示する表示装置と、被検査体の視覚を刺激して被検査体に脳の活動の開始もしくは終了を認識せしめる呈示装置とを有することを特徴とする光計測装置。

【請求項２】請求項１に記載の光計測装置において、上記呈示装置は、脳活動の開始、及び、脳活動の終了を示すバーを上記表示装置の画面上に表示することを特徴とする光計測装置。

【請求項３】請求項１に記載の光計測装置において、上記呈示装置は、脳活動の開始、及び脳活動の終了までの時間を明示する数字を上記表示装置の画面上に表示することを特徴とする光計測装置。

【請求項４】光を用いて被検査体の生体内代謝物質の濃度もしくは濃度変化を計測する光計測装置において、被検査体上に接触させる光照射器および光検出器と、被検査体内部を伝搬した光の強度変化、或いは、その強度変化から求めた生体内代謝物質の濃度もしくは濃度変化を表示する表示装置と、被検査体の聴覚を刺激して被検査体に脳の活動の開始もしくは終了を認識せしめる呈示装置を有することを特徴とする光計測装置。

【請求項５】請求項４に記載の光計測倒置において、さらにスピーカを有し、上記呈示装置は、脳活動の開始、及び、脳活動の終了を上記スピーカを通じて被検査体に音で指示することを特徴とする光計測装置。

【発明の詳細な説明】

【０００１】

【発明の属する技術分野】光を用いて生体内代謝物質濃度もしくはその濃度変化を計測し、その計測結果を用いて機器を制御するための意志誘導を行う光計測装置に関する。

【０００２】

【従来の技術】局在化している脳機能を計測して、外部装置へ入力する事により、コンピュータ、ゲーム、環境制御装置、学習度判定装置、乗物の警報装置、医療用診断及び警報装置、うそ発見器、意思表示装置、情報伝達装置などを制御する、生体入力装置、生体制御装置が、特開平９－１４９８９４にて開示されている。この入力装置、生体制御装置では、被検査体に、照射用光ファイバと検出用光ファイバを被検査体の頭皮上に装着する。照射用光ファイバは、半導体レーザ、発光ダイオード、ランプに代表される光源と接続している。そして、頭皮上で被検査体へ光を照射する。生体組織は光を強く散乱するが、その一部は、運動、感覚、言語に代表される高次脳機能が集中する大脳皮質を通過し、光照射位置から約30ミリメートル離れた頭皮へ到達する（成人の場合）。この場所に検出用光ファイバを装着し、透過した光の強度を検出する。透過光強度は、フォトダイオード、光電子増倍管に代表される光電素子を用いて光学的信号から電気的信号へ変換される。

【０００３】ここで、体を動かしたり物を考えたり念じたりすることで脳を活動させると、大脳皮質内の血液量が変化する。血液中のヘモグロビン（酸化ヘモグロビン、還元ヘモグロビン）は計測に使用する光（たとえば、近赤外光）を吸収するため、検出用光ファイバへ到達した光量は、脳活動に伴いヘモグロビン量が増加すると減少する。このため、検出した光の強度の変化は脳の活動を反映する。この生体内を伝搬した光の強度の変化を検出し、その変化量に応じて外部装置へ入力する生体入力装置、生体制御装置の制御が提案されている。

【０００４】

【発明が解決しようとする課題】被検査体が脳の活動を制御することで、生体入力装置、生体制御装置の制御を実現するためには、被検査体が安静状態にある時の生体組織透過光強度を計測している期間と、特定の（局在化している）脳機能を活動させた特の生体組織透過光強度を計測している期間に同期して、それぞれ被検査体は安静状態にある状態と特定の脳機能（例えば、運動野、感覚野、言語野など）を活性化する必要がある。この活性化を効率よく実現するためには、以下の２つの工夫が必要となる。

【０００５】第一に、生体入力装置、もしくは生体制御装置から、被検査体へ脳を活動させるタイミングを具体的に呈示する必要がある。第二に、更に、この呈示に同期して脳の活動を開始、終了させ、この結果発生した検出光強度の変化を被検査体が把握できれば、被検査体自身が脳の活動状況（意思の伝達状況）を把握することが可能になる。

【０００６】

【課題を解決するための手段】本発明では、以下の二つの呈示装置を具備する光計測導装置を提供する。第一に、被検査体の視覚もしくは聴覚を刺激することで、脳活動の開始もしくは終了を被検査体へ呈示する。

【０００７】第二に、脳活動の開始、もしくは終了に伴う生体内代謝物質の濃度変化を被検査体自身が認識できる様に、生体内を伝搬した光強度変化もしくはこれから求められる生体内代謝物質の濃度変化を被検査体へ呈示する。

【０００８】

【発明の実施の形態】（実施例）以降、図を用いて本発明に関する実施例を具体的に説明する。

【０００９】図２は本発明に基づく意志誘導を行う光計測装置の典型的な装置構成を示す。２－１は半導体レーザ、発光ダイオード、ランプに代表される光源であり、この光源の先端は、シリカ系光ファイバ、アクリル樹脂製光ファイバ、フッ素樹脂製光ファイバに代表される光

照射用光導波路２－２の先端と接触している。そして、この光導波路のもう一方の先端は、被検査体２－３の頭皮上と軽く接触している。一方、光照射用光導波路２－２と同様の素材を使用した光検出用光導波路２－４も被検査体２－３の頭皮上に軽く接触している。ここで、頭皮上での光照射用光導波路２－２と検出用光導波路２－４の配置間隔は、成人の場合３０ミリメートル間隔で配置すると、頭蓋骨の内側に存在し、ヒト固有の高次脳機能が集中する大脳皮質での血液量変化を最も効率良く計測することが可能である。しかし、ヒトの脳の構造は個体差が大きいため、この３０ミリメートルの配置間隔に限定されるものでは無い。また、例えば、運動機能を活性化させることで意思を伝達するのであれば、光照射用光導波路（２－２）と光検出用光導波路（２－４）の中点の直下が、運動野となるように、これら光導波路を配置するのが望ましい。何故ならば、この中点の直下での血液量変化の感度が最大であるからである。２－５は光検出用光ファイバを伝搬した透過光強度を電気的信号に変換する光電素子である。この光電素子の具体的な形態として、アバランシェフォトダイオード、光電子増倍管が挙げられる。２－６は中央制御装置である。この中央制御装置は、光源（２－１）の出力強度を制御したり、光電素子（２－５）を用いて変換された生体内伝搬光強度をアナログ値からディジタル値へ変換する。このディジタル化された信号強度は、パーソナルコンピュータ、ワークステーションに代表される電子計算機（２－７）へ伝送される。この電子計算機には、少なくとも、ディスプレー（２－８）とスピーカー（２－９）の何れかを具備している。このディスプレー（２－８）の画面構成に関しては、以下の図１を用いて説明する。また、この図２では、一つの光源（２－１）、一つの光電素子（２－５）、一つの光照射用光導波路（２－２）と一つの検出用光導波路（２－４）を使用し、一チャンネル計測を実施する場合の装置構成図を示している。しかし、本実施例で提供する意思誘導を行う光計測装置は、この一チャンネル計測に限定されるものではなく、多チャンネル計測でも何ら問題なく実施できるものである。

【００１０】次に、図２に示した計測方法を用いて、生体内代謝物質濃度の変化を計測する方法を説明する（図３）。まず、図２に示した計測方法を用いて、光照射用光導波路（２－２）と検出用光導波路を（２－４）を被検査体（２－３）の頭皮上に接触させたと仮定する。ヒトの脳は、頭皮の内側に、頭蓋骨（３－１）、脳脊髄液層（３－２）、大脳皮質（３－３）などが層状に存在する。３－４は光照射用光導波路であり、頭皮に軽く接触している。生体組織は光を強く散乱する。散乱された光の一部は、頭蓋骨の内側に存在しヒト固有の高次脳機能が集中している大脳皮質を経由し、３－５に示した検出用光導波路と頭皮の接触点へ到達する。ここで、脳が活動すると、脳神経細胞の活動部位へ、酸素やグルコースを供給するために、大脳皮質内の血液量が変化する（３－６）。血液中のヘモグロビン（酸化ヘモグロビン、還元ヘモグロビン）は計測に使用する光を吸収する。ここで、計測には、生体組織透過性が高い（生体中の水やタンパク質に吸収され難い）近赤外光（波長：８００ナノメートル前後）を使用するのがもっとも望ましい。このため、例えば、脳が活動することで、大脳皮質の血液量が増加すると、検出される光の強度は減少する。

【００１１】これら図２、図３に示した装置構成および計測原理を用いた意思誘導装置の画面構成図を用いて説明する（図１）。１－１は画面である。この画面上には、横軸（１－２）と縦軸（１－３）が表示されている。各横軸、縦軸は、各々計測時間、透過光強度を意味している。また、図中の実線（１－４）は、透過光強度を示す。この透過光強度の変化は、計測中に実時間で表示する。尚、この透過光強度の変化は脳の活動を反映するので、透過光強度変化から求めた生体内代謝物質の濃度変化（酸化ヘモグロビン、還元ヘモグロビン、全ヘモグロビン）を表示しても何等問題はない。被検査体へ脳活動の開始と終了を告知する表示手段として、本実施例では、１－５、１－６に示した「脳活動の開始」、「脳活動の終了」を示すバーを画面上に表示する。計測が開始されると、画面上に透過光強度が表示される。この時、被検査体は、安静にしている。そして、脳活動の開始時刻になると、例えば、被検査体は、体の一部を動かしたり、物を考えたりすることで脳を活動させる。さらに、脳活動の終了時刻になると、被検査体は再び安静状態にする。

【００１２】図１に示した計測方法と同様に被検査体へ脳活動の開始および終了を提示する方法を図４に示す。４－１は表示画面であり、この画面上に、縦軸（４－２）と横軸（４－３）が表示されている。各横軸と縦軸は、各々計測時間と透過光強度を意味している。さらに、これら縦軸と横軸を用いたグラフ上に、透過光強度（４－４）が実時間で表示される。さらに、この画面上には、タスク開始およびタスク終了までの時間を明示する数字（４－５）が存在する。この図では、タスク終了までの時間が明示されている。残り時間が提示されているため、被検査体はあとどの程度の時間、脳を活動させたらよいのかが、把握できる。

【００１３】次に、図２に示したスピーカー（２－９）とディスプレー（２－８）を用いて、脳活動の開始および終了、および生体内を伝搬した光の強度変化もしくはこれから求められる生体内代謝物質の濃度変化を被検査体へ提示する方法を用いて説明する（図５）。５－１はディスプレー（２－８）に表示される生体内を伝搬した光の強度変化を表示する画面を示している。本実施例では、検出用光導波路（２－４）を用いて検出した生体内を伝搬した光の強度変化を図示しているが、本実施例以外に、この強度変化から計算した生体内代謝物質（酸化

ヘモグロビン、還元ヘモグロビン、ミオグロビンなど）の濃度もしくは濃度変化を表示していても何等問題は無い。この生体内を伝搬した光の強度変化は計測時においてリアルタイムで表示される。この生体内を伝搬した光の強度変化の表示に同期して、５－２に示したタイミングで、スピーカーから音を発する。本実施例では、５－３では脳活動の開始を、５－４では脳活動の終了を被検査体へ指示する。５－３に示した脳活動の開始を被検査体へ指示する音と、５－４に示した脳活動の終了を指示する音は、その強度、周波数などに代表される音質が異なっていることが望ましい。何故ならば、このような工夫により、脳活動の開始と終了を明確に認識することが可能になるからである。

【００１４】次に、図１および図２に示した実施例を用いて生体内組織を伝搬し検出した光強度を検出した結果を図６に示す。この計測では、光照射用光導波路２－２と光検出用光導波路２－４を被検査体２－３の左半球上の「運動野」上に30ミリメートル間隔で配置した。また、グラフ中の０～３０秒、および５０～８０秒において、被検査体は安静状態にあった。一方、３０～５０秒では、被検査体の右手をグリッピング（じゃんけんのグーとパーを１ヘルツで繰り返す）した。グリッピング期間中の透過光強度は、この期間の前後である安静状態と比較して小さい。これは、脳の活動に伴う血液量の増加と対応している。

【００１５】これまで、本発明に係る光計測装置について、代表例をあげて説明してきたが、さらに、この装置を用いることで以下の応用技術が実現できる。

【００１６】(１)発話が困難な患者の意思伝達装置

ＡＬＳ（筋萎縮性側索硬化症）の患者は、次第に筋力が衰える。この結果、会話に代表される意思の伝達が困難になる。しかし、物を考えることで脳が活動し、その結果、生体内代謝物質の濃度が変化するのであれば、その濃度もしくは濃度変化量を計測することでコミュニケーションを図ることが可能になる。

【００１７】(２)バイオフィードバックを用いたリハビリテーション

図６では、指のグリッピング動作に伴う、脳内での血液量変化を表示している。被検査体は、グリッピングの開始、終了と、一連の動作に伴う脳内の血液量変化を画面上で知りえる。例えば、何らかの事故等により、手を動かす機能が低下した者がいたとする。図１、図２に示した意思誘導装置を用いて、図６に示した画面上に運動野の活性化状況が表示されるので、これを見ながらトレーニングを行うことが可能になる。

【００１８】(３)遊技機への応用

図２に示した実施例では、血液量変化を計測することが可能である。また、指を動かす頻度を変えることで、血液量の変化を制御することも可能である。このため、複数人の血液量変化を定量的に計測し、その計測結果を用いて血液量変化を競わせる遊技機への応用が可能になる。

【００１９】

【発明の効果】本発明に基づく意志誘導を行う光計測装置を用いることで、被検査体は自らの生体内を伝搬した光の強度変化もしくは脳活動に伴う生体内代謝物質の濃度もしくは濃度変化と、脳活動の開始と終了に関する時間的な対応を把握することが可能になる。

【図面の簡単な説明】

【図１】視覚刺激法による意思誘導装置の画面構成（１）。

【図２】意志誘導を行う光計測装置の装置構成。

【図３】脳の構造、生体内光伝搬特性、および脳活動に伴う生体内代謝物質の濃度増加のイメージ。

【図４】視覚刺激法による意志誘導を行う光計測装置の画面構成（２）。

【図５】聴覚刺激法による意志誘導を行う光計測装置の画面構成と制御シーケンス。

【図６】本発明に基づく意志誘導を行う光計測装置を用いた実験結果例。

【符号の説明】

１－１：画面、１－２：横軸、１－３：縦軸、１－４：透過光強度、１－５：「脳活動の開始」を示すバー、１－６：「脳活動の終了」を示すバー

２－１：半導体レーザ、発光ダイオード、ランプに代表される光源、２－２：シリカ系光ファイバ、アクリル樹脂製光ファイバ、フッ素樹脂製光ファイバに代表される光照射用光導波路、２－３：被検査体、２－４：光検出用光導波路、２－５：アバランシェフォトダイオード、光電子増倍管に代表される光電素子、２－６：中央制御装置、２－７：パーソナルコンピュータ、ワークステーションに代表される電子計算機、２－８：ディスプレー、２－９：スピーカー

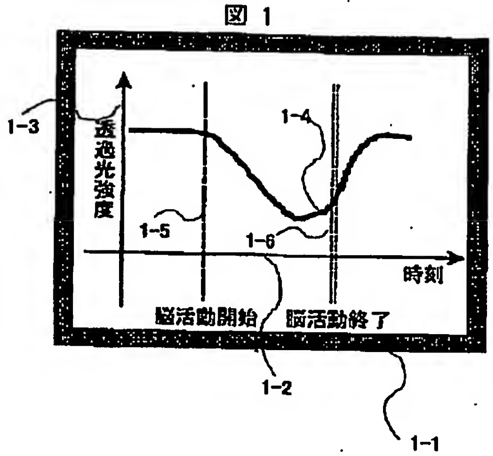
３－１：頭蓋骨、３－２：脳脊髄液層、３－３：大脳皮質、３－４：照射用光導波路、３－５：検出用光導波路、３－６：血液量変化領域

４－１：表示画面、４－２：縦軸、４－３：横軸、４－４：透過光強度、４－５：数字

５－１：ディスプレー（２－８）に表示される生体内を伝搬した光の強度変化を表示する画面、５－２：スピーカから音を発するタイミング、５－３：脳活動の開始を被検査体へ指示する音、５－４：脳活動の終了を指示する音。

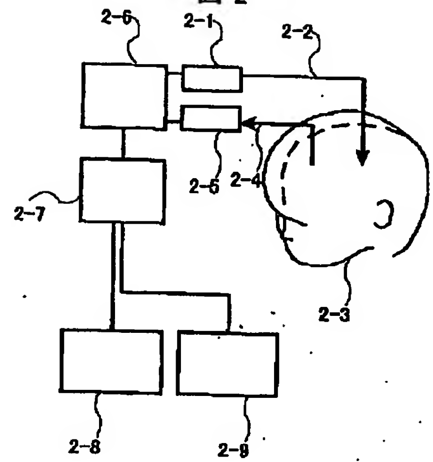
【図１】

図 1



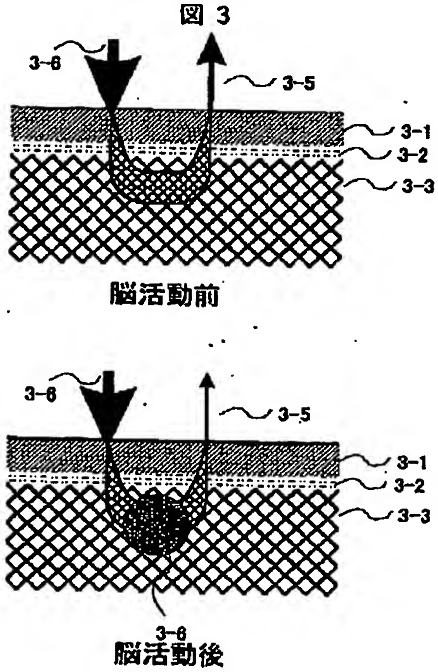
【図２】

図 2



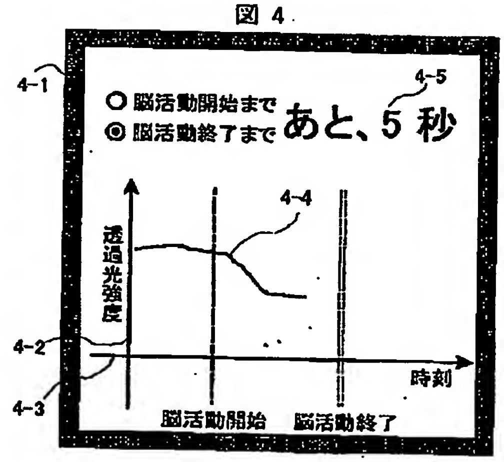
【図３】

図 3



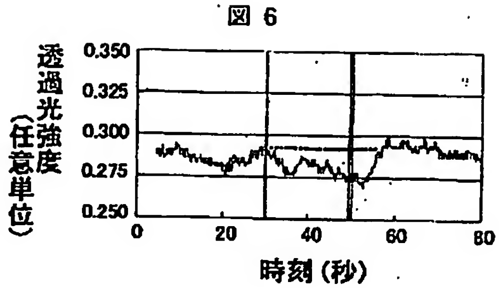
【図４】

図 4



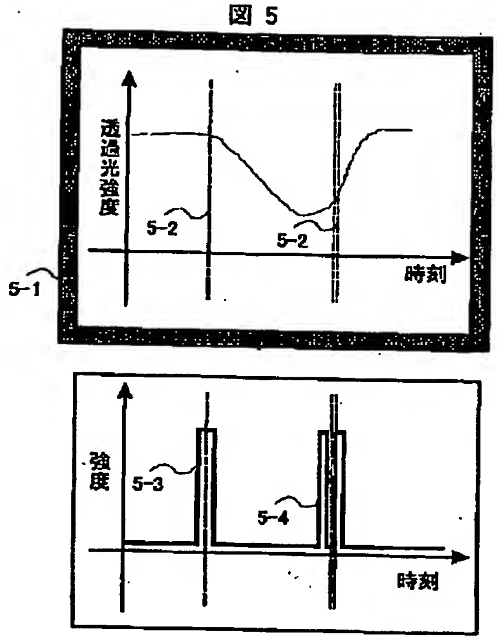
【図６】

図 6



【図５】

図 5



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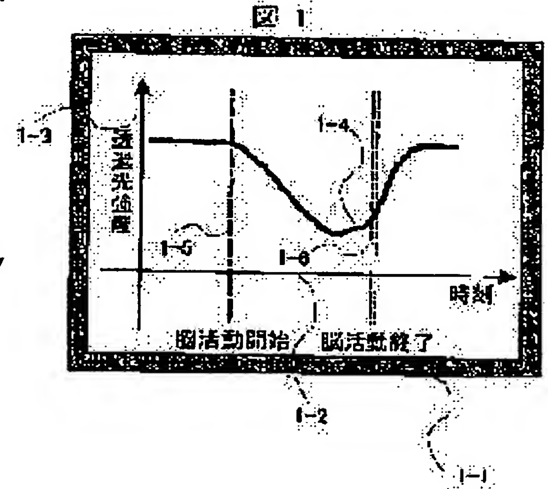
(54) LIGHT MEASURING DEVICE

(57)Abstract:
PROBLEM TO BE SOLVED: To provide a light measuring device performing will induction with which a subject can grasp initiation and completion of a brain activity and a change of the concentration of a metabolite in the body easily.
SOLUTION: The device having a light irradiator and a light detector both being in contact with a subject to measure the change of the concentration of the metabolite in the body by the use of light has a device that displays an actual time for a change of the intensity of the light transmitted through the subject or the concentration or the change of the concentration of the metabolite in the body calculated by the change of the intensity of the light and an exhibition device that stimulates a sight of the subject for making the subject to recognize initiation and completion of the brain activity.

図 1



LEGAL STATUS

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[Number of appeal against examiner's decision of rejection]
[Date of requesting appeal against examiner's

decision of rejection]
[Date of extinction of right]

CLAIMS

[Claim(s)]
[Claim 1] In the optical metering device which measures the concentration of the metabolite of an inspected object in the living body, or concentration change using light the optical exposure machine and photodetector which are contacted on an inspected object, and luminous-intensity change which spread the interior of an inspected object — or The optical metering device characterized by having the display which displays the concentration of a metabolite in the living body or concentration change for which it asked from the change on the strength, and presentation equipment which the vision of an inspected object is stimulated [equipment] and makes an inspected object recognize initiation or termination of a cerebral activity.
[Claim 2] It is the optical metering device characterized by displaying the bar which the above-mentioned presentation equipment shows initiation of a brain activity, and termination of a brain activity in an optical metering device according to claim 1 on the screen of the above-mentioned display.
[Claim 3] It is the optical metering device characterized by displaying the figure the above-mentioned presentation equipment shows the time amount to initiation of a brain activity, and termination of a brain activity to be clearly in an optical metering device according to claim 1 on the screen of the above-mentioned display.
[Claim 4] In the optical metering device which measures the concentration of the metabolite of an inspected object in the living body, or concentration change using light the optical exposure machine and photodetector which are contacted on an inspected object, and luminous-intensity change which spread the interior of an inspected object — or The optical metering device characterized by having the display which displays the concentration of a metabolite in the living body or concentration change for which it asked from the change on the strength, and presentation equipment which the acoustic sense of an inspected object is stimulated [equipment] and makes an inspected object recognize initiation or termination of a cerebral activity.
[Claim 5] It is the optical metering device which has a loudspeaker further in optical measurement inversion according to claim 4, and is characterized by the above-mentioned presentation equipment directing initiation of a brain activity, and termination of a brain activity on an inspected object to a sound through the above-mentioned loudspeaker.

[Translation done.]

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] Metabolite concentration in the living body or its concentration change is measured using light, and it is related with the optical metering device which performs volition induction for controlling a device using the measurement result.
[0002]
[Description of the Prior Art] The localized cerebral function is measured and the living body input unit and biological control equipment which control judgment equipment, the alarm of a vehicle, a medical-application diagnosis and an alarm, the lie detector, declaration-of-intention equipment, a data transmission unit, etc. whenever [computer, game, environment control unit, and study] are indicated in JP,9-149894,A by inputting into an external device. this input device and biological control equipment — an inspected object — the optical fiber for an exposure, and the optical fiber for detection — the scalp of an inspected object — it equips upwards. The optical fiber for an exposure is connected with the light source represented by semiconductor laser, light emitting diode, and the lamp. and the scalp — light is irradiated to an inspected object in a top. Although body tissues are strongly scattered about in light, the part passes the cerebral cortex which the higher brain function represented by movement, feeling, and language concentrates, and reaches to the scalp about 30mm away from the optical exposure location (in the case of an adult). This location is equipped with the optical fiber for detection, and the transmitted luminous intensity is detected. Transmitted light reinforcement is changed into an electric signal from an optical signal using the photoelectric element represented by a photodiode and the photomultiplier tube.
[0003] Here, if a brain is made to work by moving the body, considering an object or praying, the blood volume in the cerebral cortex will change. In order that the hemoglobin in blood (an oxyhemoglobin, reduced hemoglobin) may absorb the light (for example, near-infrared light) used for measurement, the quantity of light which reached to the optical fiber for detection will decrease, if the amount of hemoglobin increases with a brain activity. For this reason, change of the detected luminous intensity reflects a cerebral activity. Change of the luminous intensity which spread in the living body [this] is detected, and control of the living body input unit inputted into an external device according to that variation and biological control equipment is proposed.
[0004]
[Problem(s) to be Solved by the Invention] In order to realize control of a living body input unit and biological control equipment, because an inspected object controls a cerebral activity The period which is measuring body tissue transmitted light reinforcement in case an inspected object is in a rest condition, Synchronizing with the period which is measuring the body tissue transmitted light reinforcement of ** which made the specific cerebral function (it has localized) work, an inspected object needs to activate the condition of being in a rest condition, and specific cerebral functions (for example, the motor area, a sensory area, the speech center, etc.), respectively. In order to realize this activation efficiently, the following two devices are needed.
[0005] In the first place, it is necessary to show concretely the timing which makes a brain work

to an inspected object from a living body input unit or biological control equipment. Synchronize with this presentation and the second is made to start and end a cerebral activity further, and if an inspected object can grasp change of the detection light reinforcement generated as a result, it will enable the inspected object itself to grasp a cerebral activity situation (transfer situation of an intention).
[0006]
[Means for Solving the Problem] In this invention, optical measurement ****** possessing two following presentation equipments is offered. In the first place, initiation or termination of a brain activity is shown to an inspected object by stimulating the vision or the acoustic sense of an inspected object.
[0007] Concentration change of the metabolite in the living body for which the second is asked a change on the strength [optical] which spread in the living body, or after this so that the inspected object itself can recognize initiation of a brain activity or concentration change of the metabolite in the living body accompanying termination is shown to an inspected object.
[0008]
[Embodiment of the Invention] (Example) The example about this invention is henceforth explained concretely using drawing.
[0009] Drawing 2 shows the typical equipment configuration of the optical metering device which performs volition induction based on this invention. 2-1 is the light source represented by semiconductor laser, light emitting diode, and the lamp, and the tip of this light source touches the tip of the optical waveguide 2-2 for an optical exposure represented by a silica system optical fiber, the optical fiber made of acrylic resin, and the optical fiber made of a fluororesin. and another tip of this optical waveguide — the scalp of the inspected object 2-3 — it is lightly in contact the top. the optical waveguide 2-4 for photodetection which, on the other hand, used the same material as the optical waveguide 2-2 for an optical exposure — the scalp of the inspected object 2-3 — it is lightly in contact upwards. here — the scalp — if arrangement spacing of the upper optical waveguide 2-2 for an optical exposure and the optical waveguide 2-4 for detection is arranged at intervals of 30 millimeters in an adult, it can measure most efficiently the blood volume change by the cerebral cortex which exists inside a skull and the higher brain function of a Homo sapiens proper concentrates However, since the structure of a human brain has large individual difference, there is what is limited to this arrangement spacing that is 30 millimeters. [no] Moreover, if an intention is transmitted by activating a motor function for example, it is desirable to arrange these optical waveguides so that it may become the motor area directly under the middle point of the optical waveguide for an optical exposure (2-2), and the optical waveguide for photodetection (2-4). It is because the sensibility of blood volume change directly under [of this middle point] is max. 2-5 is a photoelectric element which changes into an electric signal the transmitted light reinforcement which spread the optical fiber for photodetection. An avalanche photodiode and the photomultiplier tube are mentioned as a concrete gestalt of this photoelectric element. 2-6 is a central control unit. This central control unit controls the output reinforcement of the light source (2-1), or changes into digital value the propagation light reinforcement in the living body changed using the photoelectric element (2-5) from an analog value. This digitized signal strength is transmitted to the computer (2-7) represented to a personal computer and a workstation. In this computer, it provides at least any of a display (2-8) and a loudspeaker (2-9) they are. The screen configuration of this display (2-8) is explained using the following drawing 1 . Moreover, by this drawing 2 , the one light source (2-1), one photoelectric element (2-5), one optical waveguide for an optical exposure (2-2), and one optical waveguide for detection (2-4) are used, and the equipment configuration Fig. in the case of carrying out one-channel measurement is shown. However, the optical metering device which performs intention induction offered by this example is not limited to this one-channel measurement, and multi-channel measurement can also carry it out satisfactory at all.
[0010] Next, how to measure change of metabolite concentration in the living body is explained using the measurement approach shown in drawing 2 (drawing 3 R> 3). first, the measurement approach shown in drawing 2 — using — the optical waveguide for an optical exposure (2-2), and the optical waveguide for detection — (2-4) — the scalp of an inspected object (2-3) — it

is assumed that it made it contact upwards. As for a human brain, a skull (3-1), a cerebrospinal fluid layer (3-2), the cerebral cortex (3-3), etc. exist in the shape of a layer inside the scalp. 3-4 is the optical waveguide for an optical exposure, and touches the scalp lightly. Body tissues are strongly scattered about in light. A part of scattered light reaches via the cerebral cortex which exists inside a skull and the higher brain function of a Homo sapiens proper is concentrating to the point of contact of the optical waveguide for detection and the scalp which were shown in 3-5. Here, if a brain works, in order to supply oxygen and a glucose to the activity part of a cranial nerve cell, the blood volume in the cerebral cortex changes (3-6). The hemoglobin in blood (an oxyhemoglobin, reduced hemoglobin) absorbs the light used for measurement. Here, it is most desirable to use near-infrared light (wavelength: before or after 800 nanometers) with high (for water and protein in a living body to be hard to be absorbed) body tissue permeability for measurement. For this reason, for example, if the blood volume of the cerebral cortex increases because a brain works, the luminous intensity detected will decrease.

[0011] It explains using the screen block diagram of the intention guide using the equipment configuration and measurement principle which were shown in these drawing 2 and drawing 3 (drawing 1). 1-1 is a screen. On this screen, the axis of abscissa (1-2) and the axis of ordinate (1-3) are displayed. Each axis of abscissa and an axis of ordinate mean measurement time amount and transmitted light reinforcement respectively. Moreover, the continuous line in drawing (1-4) shows transmitted light reinforcement. Change of this transmitted light reinforcement is displayed in the real time during measurement. In addition, since change of this transmitted light reinforcement reflects a cerebral activity, even if it displays concentration change (an oxyhemoglobin, reduced hemoglobin, all hemoglobin) of the metabolite in the living body for which it asked from a transmitted light change on the strength, it is satisfactory in any way. As a display means to notify of initiation and termination of a brain activity, the bar in which "initiation of a brain activity" shown in 1-5 and 1-6 and "termination of a brain activity" are shown is displayed on an inspected object on a screen by this example. Initiation of measurement displays transmitted light reinforcement on a screen. The inspected object is made into the rest at this time. And when the start time of a brain activity comes, for example, an inspected object makes a brain work by moving bodily [some] or considering an object. Furthermore, if the end time of a brain activity comes, an inspected object will be again changed into a rest condition.

[0012] The measurement approach shown in drawing 1 and the method of showing initiation and termination of a brain activity to an inspected object similarly are shown in drawing 4 . 4-1 is the display screen and the axis of ordinate (4-2) and the axis of abscissa (4-3) are displayed on this screen. Each axis of abscissa and an axis of ordinate mean measurement time amount and transmitted light reinforcement respectively. Furthermore, transmitted light reinforcement (4-4) is displayed in the real time on the graph using these axes of ordinate and an axis of abscissa. Furthermore, on this screen, the figure (4-5) which specifies the time amount to task initiation and the end of task exists. In this drawing, the time amount to the end of task is specified. Since residual time is shown, it can grasp whether an inspected object should just make the time amount of after how much, and a brain work.

[0013] Next, it explains using the approach of showing concentration change of the metabolite in the living body called for initiation of a brain activity, termination and luminous-intensity change that spread in the living body, or from now on to an inspected object, using the loudspeaker (2-9) and display (2-8) which were shown in drawing 2 (drawing 5). 5-1 shows the screen which displays luminous-intensity change which spread in the living body it is displayed in the living body on a display (2-8). Although luminous-intensity change which spread in the living body it detected in the living body using the optical waveguide for detection (2-4) is illustrated in this example, even if it is displaying the concentration of metabolites (an oxyhemoglobin, the reduced hemoglobin, myoglobin, etc.) in the living body or concentration change calculated from this change on the strength in addition to this example, it is satisfactory in any way. Luminous-intensity change which spread in the living body [this] is expressed as real time at the time of measurement. Synchronizing with the display of luminous-intensity change which spread in the living body [this], a sound is emitted from a loudspeaker to the timing shown in 5-2. In this

example, termination of the brain activity by 5-4 by initiation of a brain activity is directed to an inspected object 5-3. As for the sound which directs initiation of the brain activity shown in 5-3 to an inspected object, and the sound which directs termination of the brain activity which showed 5-4, it is desirable for the tone quality represented by the reinforcement, the frequency, etc. to differ. It is because such a device enables it to recognize initiation and termination of a brain activity clearly.

[0014] Next, the result of having detected the optical reinforcement which spread and detected the organization in the living body using the example shown in drawing 1 and drawing 2 is shown in drawing 6 . In this measurement, the optical waveguide 2-2 for an optical exposure and the optical waveguide 2-4 for photodetection have been arranged at intervals of 30 millimeters on the "motor area" on the left semi-sphere of the inspected object 2-3. Moreover, in 0 - 30 seconds in a graph, and 50 - 80 seconds, the inspected object suited the rest condition. On the other hand, in 30 - 50 seconds, gripping (a par is repeated by 1 Hertz as janken is good) of the right hand of an inspected object was carried out. The transmitted light reinforcement in a gripping period is small as compared with the rest condition which it is before or after this period. This corresponds with the increment in the blood volume accompanying a cerebral activity.

[0015] Although the example of representation has so far been given and explained about the optical metering device concerning this invention, the applied technology of the following [using this equipment] is realizable further.

[0016] (1) The patient's of a patient's intention transport unit ALS with difficult utterance (amyotrophic lateralsclerosis) muscular power declines gradually. Consequently, transfer of the intention represented by conversation becomes difficult. However, if a brain works by considering an object, consequently the concentration of a metabolite in the living body changes, it will become possible to aim at communication by measuring the concentration or concentration variation.

[0017] (2) In rehabilitation drawing 6 using biofeedback, the blood volume change accompanying gripping actuation of a finger within a brain is displayed. An inspected object can know the blood volume change within initiation of gripping, termination, and the brain accompanying a series of actuation on a screen. For example, suppose that there were those to whom the function to move a hand fell according to a certain accident etc. Since the activation situation of the motor area is displayed on the screen shown in drawing 6 using the intention guide shown in drawing 1 and drawing 2 , it becomes possible to train looking at this.

[0018] (3) It is possible to measure blood volume change in the example shown in application drawing 2 to a game machine. Moreover, it is also possible to control change of blood volume by changing the frequency where a finger is moved. For this reason, two or more persons' blood volume change is measured quantitatively, and the application to the game machine which makes it compete for blood volume change using that measurement result is attained.

[0019]

[Effect of the Invention] By using the optical metering device which performs volition induction based on this invention, it enables an inspected object to grasp the time correspondence about initiation and termination of a brain activity as the concentration of a metabolite in the living body or concentration change accompanying luminous-intensity change or the brain activity which spread in the living body [one's].

[Translation done.]

TECHNICAL FIELD

[Field of the Invention] Metabolite concentration in the living body or its concentration change is measured using light, and it is related with the optical metering device which performs volition induction for controlling a device using the measurement result.

[Translation done.]

PRIOR ART

[Description of the Prior Art] The localized cerebral function is measured and the living body input unit and biological control equipment which control judgment equipment, the alarm of a vehicle, a medical-application diagnosis and an alarm, the lie detector, declaration-of-intention equipment, a data transmission unit, etc. whenever [computer, game, environment control unit, and study] are indicated in JP,9-149894,A by inputting into an external device. this input device and biological control equipment — an inspected object — the optical fiber for an exposure, and the optical fiber for detection — the scalp of an inspected object — it equips upwards. The optical fiber for an exposure is connected with the light source represented by semiconductor laser, light emitting diode, and the lamp. and the scalp — light is irradiated to an inspected object in a top. Although body tissues are strongly scattered about in light, the part passes the cerebral cortex which the higher brain function represented by movement, feeling, and language concentrates, and reaches to the scalp about 30mm away from the optical exposure location (in the case of an adult). This location is equipped with the optical fiber for detection, and the transmitted luminous intensity is detected. Transmitted light reinforcement is changed into an electric signal from an optical signal using the photoelectric element represented by a photodiode and the photomultiplier tube.
[0003] Here, if a brain is made to work by moving the body, considering an object or praying, the blood volume in the cerebral cortex will change. In order that the hemoglobin in blood (an oxyhemoglobin, reduced hemoglobin) may absorb the light (for example, near-infrared light) used for measurement, the quantity of light which reached to the optical fiber for detection will decrease, if the amount of hemoglobin increases with a brain activity. For this reason, change of the detected luminous intensity reflects a cerebral activity. Change of the luminous intensity which spread in the living body [this] is detected, and control of the living body input unit inputted into an external device according to that variation and biological control equipment is proposed.

[Translation done.]

EFFECT OF THE INVENTION

[Effect of the Invention] By using the optical metering device which performs volition induction based on this invention, it enables an inspected object to grasp the time correspondence about initiation and termination of a brain activity as the concentration of a metabolite in the living body or concentration change accompanying luminous-intensity change or the brain activity which spread in the living body [one's].

[Translation done.]

TECHNICAL PROBLEM

[Problem(s) to be Solved by the Invention] In order to realize control of a living body input unit and biological control equipment, because an inspected object controls a cerebral activity The period which is measuring body tissue transmitted light reinforcement in case an inspected object is in a rest condition, Synchronizing with the period which is measuring the body tissue transmitted light reinforcement of ** which made the specific cerebral function (it has localized) work, an inspected object needs to activate the condition of being in a rest condition, and specific cerebral functions (for example, the motor area, a sensory area, the speech center, etc.), respectively. In order to realize this activation efficiently, the following two devices are needed. [0005] In the first place, it is necessary to show concretely the timing which makes a brain work to an inspected object from a living body input unit or biological control equipment. Synchronize with this presentation and the second is made to start and end a cerebral activity further, and if an inspected object can grasp change of the detection light reinforcement generated as a result, it will enable the inspected object itself to grasp a cerebral activity situation (transfer situation of an intention).

[Translation done.]

MEANS

[Means for Solving the Problem] In this invention, optical measurement ****** possessing two following presentation equipments is offered. In the first place, initiation or termination of a brain activity is shown to an inspected object by stimulating the vision or the acoustic sense of an inspected object.
[0007] Concentration change of the metabolite in the living body for which the second is asked a change on the strength [optical] which spread in the living body, or after this so that the inspected object itself can recognize initiation of a brain activity or concentration change of the metabolite in the living body accompanying termination is shown to an inspected object.
[0008]
[Embodiment of the Invention]

[Translation done.]

EXAMPLE

(Example) The example about this invention is henceforth explained concretely using drawing.
[0009] Drawing 2 shows the typical equipment configuration of the optical metering device which performs volition induction based on this invention. 2-1 is the light source represented by semiconductor laser, light emitting diode, and the lamp, and the tip of this light source touches the tip of the optical waveguide 2-2 for an optical exposure represented by a silica system optical fiber, the optical fiber made of acrylic resin, and the optical fiber made of a fluororesin. and another tip of this optical waveguide — the scalp of the inspected object 2-3 — it is lightly in contact the top. the optical waveguide 2-4 for photodetection which, on the other hand, used the same material as the optical waveguide 2-2 for an optical exposure — the scalp of the inspected object 2-3 — it is lightly in contact upwards. here — the scalp — if arrangement spacing of the upper optical waveguide 2-2 for an optical exposure and the optical waveguide 2-4 for detection is arranged at intervals of 30 millimeters in an adult, it can measure most efficiently the blood volume change by the cerebral cortex which exists inside a skull and the higher brain function of a Homo sapiens proper concentrates However, since the structure of a human brain has large individual difference, there is what is limited to this arrangement spacing that is 30 millimeters. [no] Moreover, if an intention is transmitted by activating a motor function for example, it is desirable to arrange these optical waveguides so that it may become the motor area directly under the middle point of the optical waveguide for an optical exposure (2-2), and the optical waveguide for photodetection (2-4). It is because the sensibility of blood volume change directly under [of this middle point] is max. 2-5 is a photoelectric element which changes into an electric signal the transmitted light reinforcement which spread the optical fiber for photodetection. An avalanche photodiode and the photomultiplier tube are mentioned as a concrete gestalt of this photoelectric element. 2-6 is a central control unit. This central control unit controls the output reinforcement of the light source (2-1), or changes into digital value the propagation light reinforcement in the living body changed using the photoelectric element (2-5) from an analog value. This digitized signal strength is transmitted to the computer (2-7) represented to a personal computer and a workstation. In this computer, it provides at least any of a display (2-8) and a loudspeaker (2-9) they are. The screen configuration of this display (2-8) is explained using the following drawing 1 . Moreover, by this drawing 2 , the one light source (2-1), one photoelectric element (2-5), one optical waveguide for an optical exposure (2-2), and one optical waveguide for detection (2-4) are used, and the equipment configuration Fig. in the case of carrying out one-channel measurement is shown. However, the optical metering device which performs intention induction offered by this example is not limited to this one-channel measurement, and multi-channel measurement can also carry it out satisfactory at all.
[0010] Next, how to measure change of metabolite concentration in the living body is explained using the measurement approach shown in drawing 2 (drawing 3 R> 3). first, the measurement approach shown in drawing 2 — using — the optical waveguide for an optical exposure (2-2), and the optical waveguide for detection — (2-4) — the scalp of an inspected object (2-3) — it is assumed that it made it contact upwards. As for a human brain, a skull (3-1), a cerebrospinal fluid layer (3-2), the cerebral cortex (3-3), etc. exist in the shape of a layer inside the scalp. 3-4 is the optical waveguide for an optical exposure, and touches the scalp lightly. Body tissues are

strongly scattered about in light. A part of scattered light reaches via the cerebral cortex which exists inside a skull and the higher brain function of a Homo sapiens proper is concentrating to the point of contact of the optical waveguide for detection and the scalp which were shown in 3-5. Here, if a brain works, in order to supply oxygen and a glucose to the activity part of a cranial nerve cell, the blood volume in the cerebral cortex changes (3-6). The hemoglobin in blood (an oxyhemoglobin, reduced hemoglobin) absorbs the light used for measurement. Here, it is most desirable to use near-infrared light (wavelength: before or after 800 nanometers) with high (for water and protein in a living body to be hard to be absorbed) body tissue permeability for measurement. For this reason, for example, if the blood volume of the cerebral cortex increases because a brain works, the luminous intensity detected will decrease.

[0011] It explains using the screen block diagram of the intention guide using the equipment configuration and measurement principle which were shown in these drawing 2 and drawing 3 (drawing 1). 1-1 is a screen. On this screen, the axis of abscissa (1-2) and the axis of ordinate (1-3) are displayed. Each axis of abscissa and an axis of ordinate mean measurement time amount and transmitted light reinforcement respectively. Moreover, the continuous line in drawing (1-4) shows transmitted light reinforcement. Change of this transmitted light reinforcement is displayed in the real time during measurement. In addition, since change of this transmitted light reinforcement reflects a cerebral activity, even if it displays concentration change (an oxyhemoglobin, reduced hemoglobin, all hemoglobin) of the metabolite in the living body for which it asked from a transmitted light change on the strength, it is satisfactory in any way. As a display means to notify of initiation and termination of a brain activity, the bar in which "initiation of a brain activity" shown in 1-5 and 1-6 and "termination of a brain activity" are shown is displayed on an inspected object on a screen by this example. Initiation of measurement displays transmitted light reinforcement on a screen. The inspected object is made into the rest at this time. And when the start time of a brain activity comes, for example, an inspected object makes a brain work by moving bodily [some] or considering an object. Furthermore, if the end time of a brain activity comes, an inspected object will be again changed into a rest condition.

[0012] The measurement approach shown in drawing 1 and the method of showing initiation and termination of a brain activity to an inspected object similarly are shown in drawing 4 . 4-1 is the display screen and the axis of ordinate (4-2) and the axis of abscissa (4-3) are displayed on this screen. Each axis of abscissa and an axis of ordinate mean measurement time amount and transmitted light reinforcement respectively. Furthermore, transmitted light reinforcement (4-4) is displayed in the real time on the graph using these axes of ordinate and an axis of abscissa. Furthermore, on this screen, the figure (4-5) which specifies the time amount to task initiation and the end of task exists. In this drawing, the time amount to the end of task is specified. Since residual time is shown, it can grasp whether an inspected object should just make the time amount of after how much, and a brain work.

[0013] Next, it explains using the approach of showing concentration change of the metabolite in the living body called for initiation of a brain activity, termination and luminous-intensity change that spread in the living body, or from now on to an inspected object, using the loudspeaker (2-9) and display (2-8) which were shown in drawing 2 (drawing 5). 5-1 shows the screen which displays luminous-intensity change which spread in the living body it is displayed in the living body on a display (2-8). Although luminous-intensity change which spread in the living body it detected in the living body using the optical waveguide for detection (2-4) is illustrated in this example, even if it is displaying the concentration of metabolites (an oxyhemoglobin, the reduced hemoglobin, myoglobin, etc.) in the living body or concentration change calculated from this change on the strength in addition to this example, it is satisfactory in any way. Luminous-intensity change which spread in the living body [this] is expressed as real time at the time of measurement. Synchronizing with the display of luminous-intensity change which spread in the living body [this], a sound is emitted from a loudspeaker to the timing shown in 5-2. In this example, termination of the brain activity by 5-4 by initiation of a brain activity is directed to an inspected object 5-3. As for the sound which directs initiation of the brain activity shown in 5-3 to an inspected object, and the sound which directs termination of the brain activity which

showed 5-4, it is desirable for the tone quality represented by the reinforcement, the frequency, etc. to differ. It is because such a device enables it to recognize initiation and termination of a brain activity clearly.
[0014] Next, the result of having detected the optical reinforcement which spread and detected the organization in the living body using the example shown in drawing 1 and drawing 2 is shown in drawing 6 . In this measurement, the optical waveguide 2-2 for an optical exposure and the optical waveguide 2-4 for photodetection have been arranged at intervals of 30 millimeters on the "motor area" on the left semi-sphere of the inspected object 2-3. Moreover, in 0 - 30 seconds in a graph, and 50 - 80 seconds, the inspected object suited the rest condition. On the other hand, in 30 - 50 seconds, gripping (a par is repeated by 1 Hertz as janken is good) of the right hand of an inspected object was carried out. The transmitted light reinforcement in a gripping period is small as compared with the rest condition which it is before or after this period. This corresponds with the increment in the blood volume accompanying a cerebral activity.
[0015] Although the example of representation has so far been given and explained about the optical metering device concerning this invention, the applied technology of the following [using this equipment] is realizable further.
[0016] (1) The patient's of a patient's intention transport unit ALS with difficult utterance (amyotrophic lateralsclerosis) muscular power declines gradually. Consequently, transfer of the intention represented by conversation becomes difficult. However, if a brain works by considering an object, consequently the concentration of a metabolite in the living body changes, it will become possible to aim at communication by measuring the concentration or concentration variation.
[0017] (2) In rehabilitation drawing 6 using biofeedback, the blood volume change accompanying gripping actuation of a finger within a brain is displayed. An inspected object can know the blood volume change within initiation of gripping, termination, and the brain accompanying a series of actuation on a screen. For example, suppose that there were those to whom the function to move a hand fell according to a certain accident etc. Since the activation situation of the motor area is displayed on the screen shown in drawing 6 using the intention guide shown in drawing 1 and drawing 2 , it becomes possible to train looking at this.
[0018] (3) It is possible to measure blood volume change in the example shown in application drawing 2 to a game machine. Moreover, it is also possible to control change of blood volume by changing the frequency where a finger is moved. For this reason, two or more persons' blood volume change is measured quantitatively, and the application to the game machine which makes it compete for blood volume change using that measurement result is attained.

[Translation done.]

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] The screen configuration of the intention guide by the visual-stimulus method (1).
[Drawing 2] The equipment configuration of the optical metering device which performs volition induction.
[Drawing 3] The image of the increment in concentration of cerebral structure, a living body intrinsic-light propagation property, and the metabolite in the living body accompanying a brain activity.
[Drawing 4] The screen configuration of the optical metering device which performs volition induction by the visual-stimulus method (2).
[Drawing 5] The screen configuration and control sequence of an optical metering device which perform volition induction by the acoustic-sense stimulating method.
[Drawing 6] The example of an experimental result using the optical metering device which performs volition induction based on this invention.
[Description of Notations]
1-1: A screen, a 1-2:axis of abscissa, a 1-3:axis of ordinate, 1-4 : the bar in which transmitted light reinforcement and 1-5: "initiation of a brain activity" are shown, the bar in which 1-6: "termination of a brain activity" is shown
2-1: The photoelectric element represented by the optical waveguide for an optical exposure represented by the light source represented by semiconductor laser, a light emitting diode, and the lamp, a 2-2:silica system optical fiber, the optical fiber made of acrylic resin, and the optical fiber made of a fluororesin, a 2-3:inspected object, the optical waveguide for 2-4:photodetection, a 2-5:avalanche photodiode, and the photomultiplier tube, a 2-6:central control unit, a 2-7:personal computer, the computer represented to a workstation, a 2-8:display, 2-9 : loudspeaker

3-1: A skull, a 3-2:cerebrospinal fluid layer, the 3-3:cerebral cortex, the optical waveguide for a 3-4:exposure, the optical waveguide for 3-5:detection, 3-6 : blood volume change field
4-1: The display screen, a 4-2:axis of ordinate, a 4-3:axis of abscissa, 4-4:transmitted light reinforcement, 4-5 : figure
5-1: The sound, 5-4 which direct initiation of the timing which emits a sound, and a 5-3:brain activity to an inspected object from the screen which displays luminous-intensity change which spread in the living body it is displayed in the living body on a display (2-8), and a 5-2:loudspeaker : the sound which directs termination of a brain activity.

[Translation done.]

* NOTICES *

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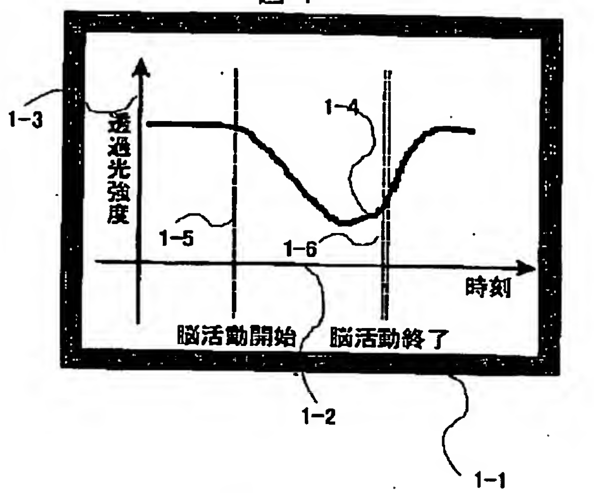
1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DRAWINGS

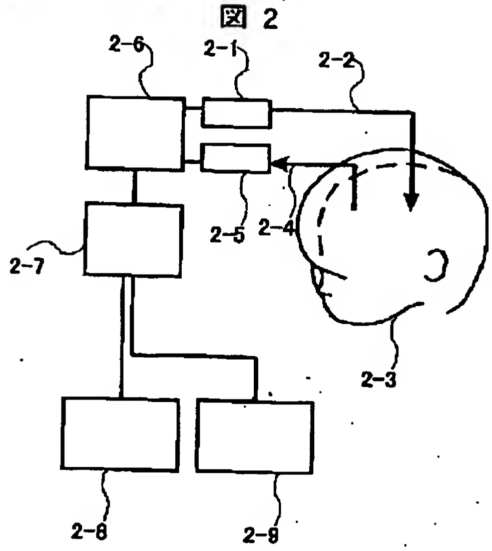
[Drawing 1]

図 1



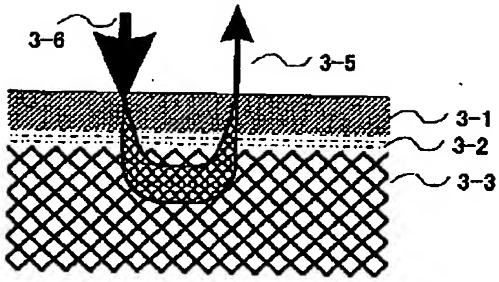
[Drawing 2]

図 2

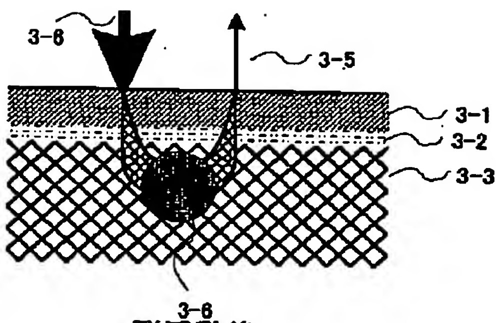


[Drawing 3]

図 3



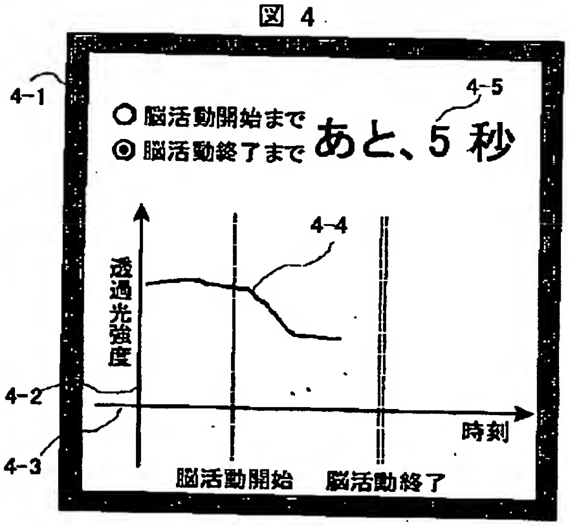
脳活動前



脳活動後

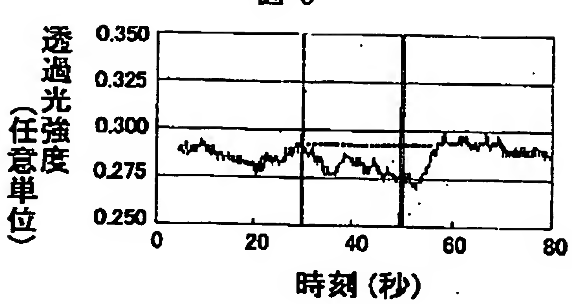
[Drawing 4]

図 4



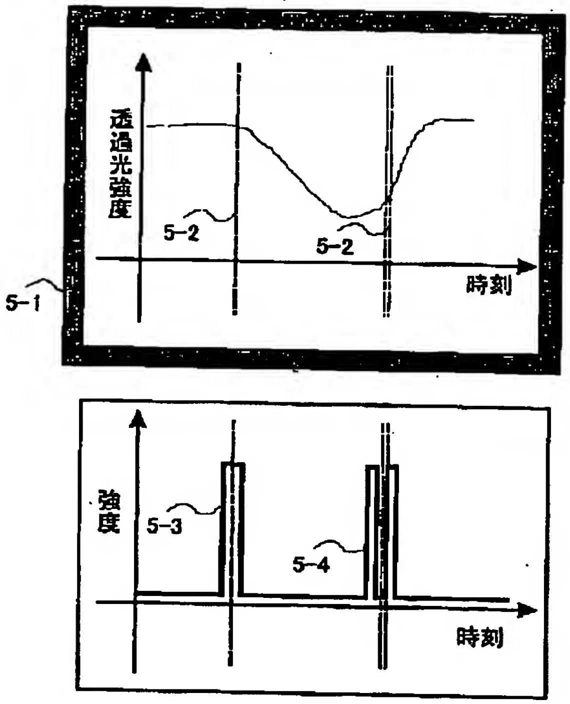
[Drawing 6]

図 6



[Drawing 5]

図 5



[Translation done.]